# Appendix 7B-3: Draft CERP Performance Assessment Protocol Paper

The interagency Restoration Coordination and Verification (RECOVER) team has the responsibility to develop and implement a systemwide Adaptive Management Program in support of the Comprehensive Everglades Restoration Plan (CERP). The purpose of the Adaptive Management Program is to create a set of measurable restoration objectives for CERP consistent with the goals of the plan, to assess how well CERP meets these objectives during and following the implementation of the plan, and to identify opportunities to improve the design and operation of the plan based on assessments of plan performance and on new information acquired through research and monitoring. The overall Adaptive Management Program includes a set of interconnected tasks and products that collectively provide RECOVER with the ability to apply the principle of adaptive management to CERP. These tasks and products include the development of conceptual ecological models of the natural systems of South Florida, a set of peer-reviewed and approved systemwide performance measures and restoration objectives, a systemwide monitoring plan, a data management and quality control strategy, and a data assessment protocol. The linkages among these components of the overall Adaptive Management Program are described in sections 1 and 2 of the *First Draft CERP Monitoring and Assessment Plan* (RECOVER, 2002). The CERP Performance Assessment protocol presented here describes the process that will be used by RECOVER to assess the information derived from the systemwide monitoring plan and other sources of new information, and to use these assessments to identify opportunities to make improvements in the design and operation of the plan in order to better meet the goals established for CERP.

This assessment protocol will be further revised and formalized upon the promulgation and codification of the programmatic regulations called for in the Water Resources Development Act of 2000, and will serve as a precursor to an assessment guidance memorandum identified in these programmatic regulations.

## INTRODUCTION AND SUMMARY

Large, complex, regional ecosystem restoration programs must have a means to measure how well the actions of these programs achieve the desired goals. Furthermore, restoration programs require a "feedback mechanism" for assessing whether or not the responses by the systems being restored match expectations, and for using these assessments to determine when and how the programs could be improved in situations where the expectations are not being met. An adaptive management program has been developed to fulfill these needs throughout the implementation of the Comprehensive Everglades Restoration Plan (CERP). The ultimate role of adaptive management in CERP is to have an ongoing, scientifically based process for substantially increasing the probability that the plan will be successful.

Adaptive management provides much needed new information about natural and human systems by actually measuring how these systems respond to manipulations, and by using this new information to improve the design and implementation strategy for restoration projects.

Adaptive management is learning by doing, and using the new information to improve processes. Adaptive management is the most effective means for acknowledging and reducing the large uncertainties pertaining to program design and system responses that inevitably are part of large ecosystem restoration programs.

The adaptive management program provides one of two opportunities available during the design and implementation of CERP projects for reducing uncertainties and improving the systemwide performance of the plan. The first of these opportunities is during the additional design work that occurs for each project as a basis for preparing a Project Implementation Report. As part of the project planning process, the predicted performance of alternative plans for meeting the project goals and for improving the systemwide performance of CERP will be determined through simulation modeling. Evaluations by the Restoration Coordination and Verification (RECOVER) team of the performance of alternative plans will provide opportunities for selecting plans that maximize CERP performance.

The second opportunity for improving plan performance is through the adaptive management program (Figure 7b-3-1). The focus of this RECOVER protocol paper is on **how RECOVER will** assess the performance of CERP, and identify opportunities to improve the performance of the plan based on monitoring and research data (lower set of grouped boxes in Figure 7b-3-1). This protocol paper only briefly summarizes and defines adaptive management as used in the context of CERP, and the steps needed to develop and implement the systemwide monitoring and assessment program. An earlier RECOVER white paper provided additional information on the overall role and value of adaptive management in ecosystem restoration programs (RECOVER

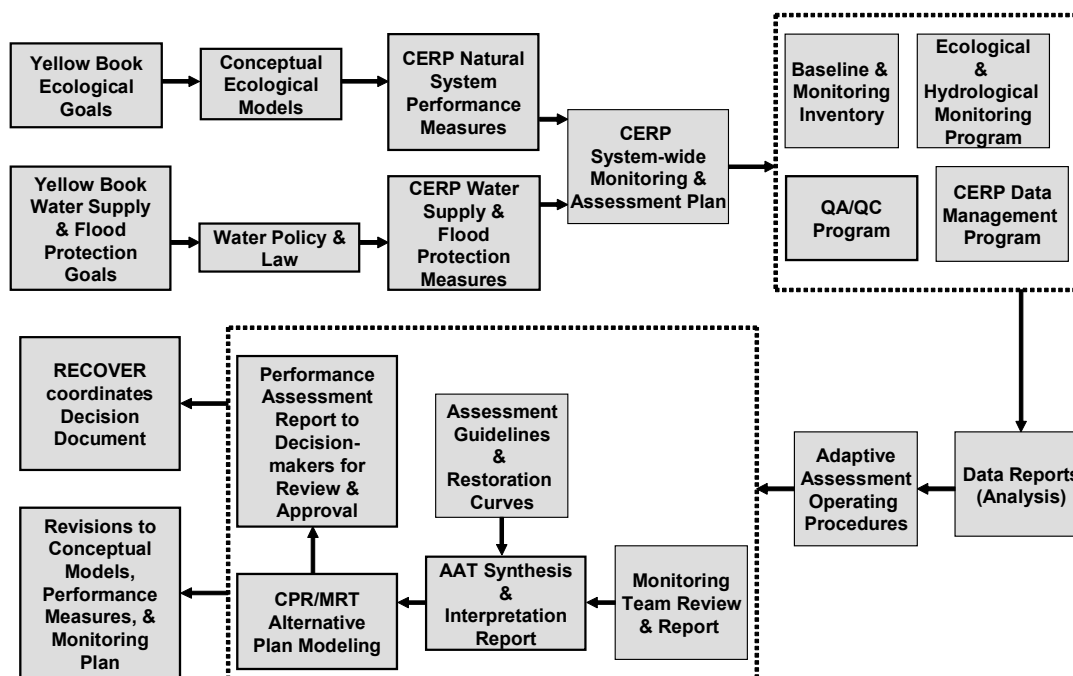## The RECOVER Adaptive Management Program



**Figure 7b-3-1.** Overall Steps in the Design and Implementation of an Adaptive Management Program in Support of CERP

Adaptive Assessment Team, 2000), while the details of the CERP systemwide monitoring plan are provided in the First *Draft CERP Monitoring and Assessment Plan* (RECOVER, 2002).

The CERP adaptive management program includes aspects of what have been termed "active" and "passive" adaptive management strategies. Active adaptive management maximizes learning and reduces uncertainty before the final project design is decided and implemented, by conducting preconstruction "experiments" that are designed to answer questions about how the systems will respond to specific restoration actions. These experiments can be designed to "test" the working hypotheses that form the basis for the predictions of system responses. The CERP pilot projects are the primary examples of active adaptive management in the current plan.

Passive adaptive management is an iterative process conducted throughout the implementation of the plan. Passive management depends on information obtained through a systemwide monitoring plan that is designed to measure the restoration objectives that have been defined by the set of CERP biological, hydrological, water quality and water supply performance measures. The system responses are compared to pre-CERP baseline conditions as a means of assessing the effects of the plan. Opportunities for "learning by doing" (i.e., monitoring and assessment) are limited to the period following construction of a project. The CERP implementation plan incorporates a passive strategy for most projects.

In the context of CERP, the overall adaptive management program includes a number of components and steps (**Figure 7b-3-1**). Collectively these components and steps are necessary to design and implement the systemwide monitoring plan, to design and activate a data management and data analyses protocol, to interpret and report system responses, and to identify opportunities for making improvements in the plan. In order to support the adaptive management program, the CERP monitoring plan is designed to:

1. measure status and trends of the selected performance measures

2. determine baseline (i.e., preproject) variability for the responses of the measures

3. address uncertainties through cause-and-effect research

4. detect unexpected and unintended system responses.

Additional details on the design and implementation of the CERP Monitoring and Assessment Plan is provided in Section II below, and are much more fully explained in that document.

The assessment protocol for interpreting responses in the natural and human systems, and for identifying opportunities for making improvements in the performance of CERP, is presented in the following two sections. Section II describes how RECOVER teams will organize and interpret new information obtained from systemwide and local monitoring and research programs in ways that will detect interim and final responses that are brought about by CERP and other features of the Central and Southern Florida (C and SF) Project. RECOVER will determine when these responses are undesirable or unintended relative to the CERP interim and final performance measures and restoration goals, and will use modeling to identify potential solutions to any performance problems. Section III proposes a set of steps for linking science and management in a joint process for determining when and how CERP should be modified in response to RECOVER assessment reports.

# II. RECOVER ADAPTIVE ASSESSMENT PROCESS

RECOVER teams will use information collected and analyzed through the CERP Monitoring and Assessment Plan as a basis for conducting five basic assessment tasks (Figure 7b-3-2). The lead responsibility for four of these tasks is with the RECOVER Adaptive Assessment Team, while the RECOVER Comprehensive Plan Refinement Team has the lead for the fifth task (see below). Additional project level monitoring and research conducted outside of CERP also may be used in the assessment process.
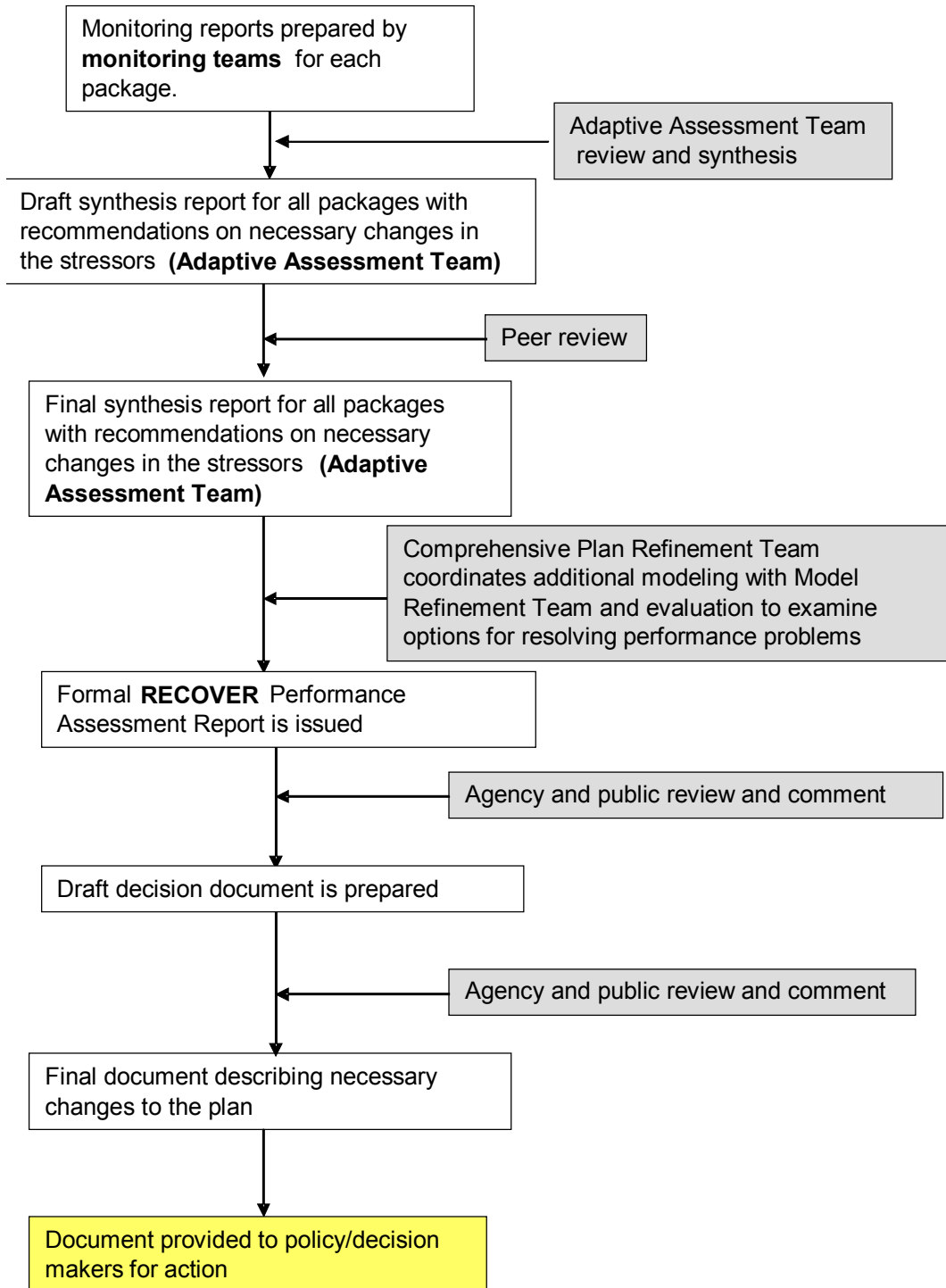
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**Figure 7b-3-2.** Sequence of Reports and Actions for Performance Assessment

The RECOVER Adaptive Assessment Team, in collaboration with the Water Quality and Regional Evaluation Teams, will have the lead for the following:

- Determining when responses by the CERP performance measures are different from natural variability and baseline conditions

- Determining if the observed responses are linked to CERP

- Comparing the responses to the interim and final objectives, and determining if the responses are undesirable (e.g., they are moving away from expectations and restoration goals, and/or are not meeting the interim goals) and at what point corrective action should be considered (e.g., how many performance measures or what magnitude of an undesirable change warrants concern?)

- Identifying what corrections in the stressors are necessary for the performance measures to respond as desired

The Adaptive Assessment Team will prepare an assessment report synthesizing the above information for consideration by RECOVER (specifically the Comprehensive Plan Refinement and Model Refinement Teams; see below).

The RECOVER Comprehensive Plan Refinement, in collaboration with the Model Refinement and Operations Planning Teams will do the following:

- Coordinate a modeling exercise as a basis for identifying one or several potential refinements in CERP design and operations needed to resolve the performance problems identified in the Adaptive Assessment Team report. The Comprehensive Plan Refinement Team will prepare a report describing the alternative plans that are modeled, and the performance benefits and potential consequences associated with each of the alternative plans.

The combined reports from the Adaptive Assessment Team and Comprehensive Plan Refinement Team will be jointly issued as RECOVER adaptive management reports. These adaptive management reports will be reviewed and approved by decision makers in the United States Army (USACE) of Engineers and the South Florida Water Management District (SFWMD) (or other local sponsor, where appropriate) as a precursor to the development of the appropriate decision document under the coordination of RECOVER. (Figure 7b-3-1; also see Section III).

## DESIGN OF THE CERP MONITORING AND ASSESSMENT PLAN

The CERP Monitoring and Assessment Plan was derived from the minimal set of performance measures that were considered by the RECOVER teams to be necessary to understand system responses to CERP. The CERP Monitoring and Assessment Plan arranges these measures into monitoring modules, organized in broad functional or physiographic groupings. Each module describes the performance measures and restoration objectives, identifies a specific set of questions that module is designed to answer, and recommends an integrated monitoring protocol for the combination of measures and questions contained in that module. Additionally, each module identifies the key uncertainties in system responses associated with that set of performance measures and the research questions that need to be answered in order to better predict and interpret system responses in the context of CERP. The research questions

focus on what is thought to be the important, yet poorly understood, causal relationships. A better understanding of these relationships will be essential for improving the accuracy of the predictive models and the systemwide assessments.

It is proposed that a multiagency and multi-institutional monitoring team will coordinate implementation of the monitoring program described in each module. Each monitoring team should have representation from the Adaptive Assessment, Water Quality and Regional Evaluation Teams and contain the expertise necessary to provide oversight for the monitoring and research needs outlined for that module.

Information collected through monitoring and assessment will provide baseline data, and status and trends for each measure in a systemwide context, as well as information on the causal relationships that underlie these trends. Additional project level monitoring will be necessary to evaluate individual projects and to provide information that can be used to improve each project's performance. The monitoring and assessment results also will be used to revise performance measures and restoration goals where needed (i.e., reevaluate working hypotheses and the organization of the conceptual ecological models).

In addition to designing and implementing the CERP Monitoring and Assessment Plan and a data management strategy (**Figure 7b-3-1**), there are a number of additional tasks that must be completed in order for the Adaptive Assessment Team to be prepared to analyze and report on the system responses to CERP. These tasks are described here.

## DETERMINE NATURAL VARIABILITY AND APPROPRIATE TEMPORAL AND SPATIAL SCALES FOR ASSESSING PERFORMANCE MEASURES

The variability of each performance measure and its context within each monitoring module will be established using a combination of historic and current preproject baseline data. Some CERP performance measures do not currently have appropriate baselines and may not be used in the assessment process for a number of years because there is no way to detect differences between "true changes" in system responses and background variability at this time. This concept of "true change" versus background variability is a challenging one and for many measures may require years of baseline data. An excellent example is total phosphorus in Lake Okeechobee which displays 1) seasonal variation due to wind, 2) year-to-year variation due to variation in loading and lake level, and 3) decadal variation related to drought.

Identification of the appropriate spatial and temporal scale for assessment will be critical for determining how each performance measure fits into each monitoring module and how it will be used in the assessment process. For example, data for some performance measures may be collected each year, but due to variability, the response time scale may be five or ten years. Because of changes in response time for each measure, different measures may be used in the assessment each year. The determination of which measures will be used in each year will be identified in the monitoring network design. It will be important to identify short-, medium-, and long-term measures for the assessment process and to remember that just because a measure will not get used in the assessment for 10 years, the data still need to be collected each year (**Figure 7b-3-3**). While responses by the final endpoint shown in this figure may not be expected except on long time scales, responses that fit a predicted trend at intermediate (interim) points would provide an early indication that the restoration plan is headed in the proper direction.
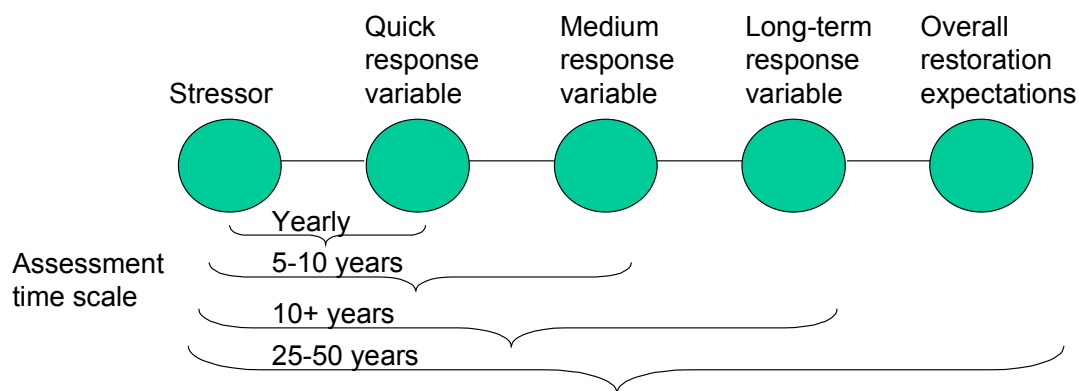
**Figure 7b-3-3.** Illustration of Temporal Scales of Measurement and Assessment.

## DEVELOP RESPONSE CURVES AND CONFIDENCE ENVELOPES FOR THESE CURVES

A question that will need to be addressed for each performance measure is as follows: How are the measures taken in the field expected to change given the changes in CERP? One way to address this is by using the output from hydrologic, water quality, and ecosystem landscape models to show the predicted rates of stressor and biological responses and then to develop response curves with appropriate confidence envelopes for each measure or set of measures. The concepts of response curves and confidence envelopes are used here in the broadest sense and may range from detailed quantitative statistical relationships to qualitative best professional judgments. Each response curve will provide a prediction of the rate and magnitude of responses by a performance measure or set of measures during and following the implementation of CERP. The refinement of these curves will be dependent on the data collected through the monitoring and research program.

As a means for developing the response curves, the Adaptive Assessment Team will use hydrologic modeling to predict future systemwide hydrological patterns, based on the rate and sequence of project implementation proposed by the current CERP Master Implementation Schedule. This modeling could be designed to show predicted hydrological patterns at five-year intervals during the implementation of CERP, and as a basis for predicting interim goals during these same time intervals.

Expected responses of the performance measures then can be developed based on these hydrologic predictions. Existing tools (ATLSS, ELM, etc.) can be used to aid in the development of response curves. Ideally, these response curves will take into account natural variability. Areas where the improvement or development of new tools could assist with the development of response curves should be identified. Actual responses that fall outside of the predicted response envelopes could result in recommendations for improvements in the plan.

The criteria for developing the confidence envelopes around the responses need to be developed. Questions such as what constitutes "real" change will be dependent on natural variability, the design of the monitoring network, and the level of confidence that we desire. It

will be necessary to consider the power of the analyses (the chance of reliably identifying a change) as well as the significance values used to determine change.

## DEVELOP CRITERIA FOR INTERPRETING INDIVIDUAL AND COLLECTIVE RESPONSES OF PERFORMANCE MEASURES

Assessments will be integrated across the system. The set of monitoring modules provides the framework for this integration. The monitoring modules have been designed to address not only individual performance measure responses but also the factors that are causing change. Within each module the assessment process will ask the following questions of each performance measure:

- Has the measure changed from the base condition?

- Is this change in the desired direction?

- Is the change occurring within the expected/desired values as described by the hydrologic modeling and response curves?

- Are the changes linked to CERP (specific projects or components)?

The assessment process will first examine the stressors. If there is no change in the stressors then any changes that are detected among the attributes may be due to natural variability or other causal factors. The Monitoring and Assessment Plan will provide information that will allow the Adaptive Assessment Team, with assistance from the Water Quality and Regional Evaluation Teams, to make this assessment. Each attribute will be examined using the same set of questions. Responses will be examined in the context of each monitoring module to determine progress toward restoration expectations.

The monitoring team responsible for implementing each module will prepare a brief yearly report for review by the Adaptive Assessment Team. That report will present the current status of each measure in the context of the monitoring module, summarize progress made in addressing key uncertainties, and provide a discussion on the direction and causes of changes. In addition, there will be a section highlighting where measures are outside of the confidence envelopes and a discussion of what changes in the stressors are necessary to improve the response of the measures and the package. Guidelines will be developed to help the monitoring teams decide when the number and magnitude of "wrong" responses is great enough to trigger a review of alternative plans for improving CERP performance.

The Adaptive Assessment Team will evaluate the reports from the monitoring teams and develop a summary report that synthesizes the information and provides an analysis of any performance problems in the natural and human systems. As a general guideline for deciding the levels of CERP influenced responses in the natural and human systems that will be considered undesirable, and thereby triggering a review of potential solutions, the predicted performance of the initial CERP (D13R and OPEs) is considered to be the minimal acceptable performance of CERP during implementation. The overall goal is to improve the performance described by D13R and OPEs, especially in those regions where the initial CERP performance was predicted to only achieve a "yellow" or "red" level of performance. Any actual system response that is less than the predicted performance for the initial CERP at any point during implementation, or that does not correct upon "yellow" or "red" performance predictions, will be considered to be potentially inadequate for meeting the restoration goals of the plan. While other levels of response or other information can lead to actions by RECOVER, this initial CERP performance threshold will

automatically trigger the review protocol described in this section. A similar performance threshold is used by RECOVER for evaluating the modeled predictions of systemwide performance by CERP projects during the development of project implementation reports.

## DETERMINE THE APPROPRIATE FREQUENCY OF RECOVER ADAPTIVE ASSESSMENT REPORTS

RECOVER needs to decide how often it will conduct formal assessments of system performance and issue performance assessment reports. While the monitoring program and the monitoring module teams are organized to collect and review, respectively, monitoring data on an annual basis, responses by most performance measures to the affects of CERP may not be detectable during one-year time frames. The high level of interannual variability in rainfall and the influences of other major climatological events (e.g., freezes, hurricanes, etc.), coupled with the expected slow response times for many ecological features of the Everglades system, suggest that formal assessment reports will not be needed annually. Additionally, the pace of implementation of CERP projects is such that major physical and operational changes in the system generally will occur at multiyear scales, rather than within-year time scales. Consideration should be given to multiyear intervals between formal assessments. Two-year intervals might be appropriate to coincide with the expected intervals for Water Resource Development Act legislation. Three-year intervals might be best for detecting and interpreting many of the expected responses in the natural system. Five-year intervals would coincide with required reporting times to the U.S. Congress, and would serve as the maximum period of time between the issuance of assessment reports.

# MODIFICATIONS TO THE COMPREHENSIVE EVERGLADES RESTORATION PLAN

The recommended steps in the process of resolving system-level performance problems and improving the systemwide performance of CERP are represented in **Figure 7b-3-1**. Successful application of the adaptive management program will require the interaction of the interagency RECOVER team, policy and decision makers, and the public, in addressing the opportunities identified by the performance assessment protocol. The assessment reports will lay the groundwork both for resolving performance problems and for improving the overall performance of the plan.

The intersection of the knowledge and views of these three groups will be where the restoration plan has the highest probability of being successful (**Figure 7b-3-4**). Scientists and resource specialists in RECOVER provide updated information on the ecological and water supply goals and on potential actions designed to resolve performance problems and provide opportunities for enhanced performance within the context of CERP. Management and policy makers provide agency perspectives and represent what is possible and practical with the implementation and redesign of CERP. The public provides independent review and the perspective of regional stakeholders. Incorporating the views of these groups into the decision making process for alterations in CERP will be critical to the long-term success of the restoration program.
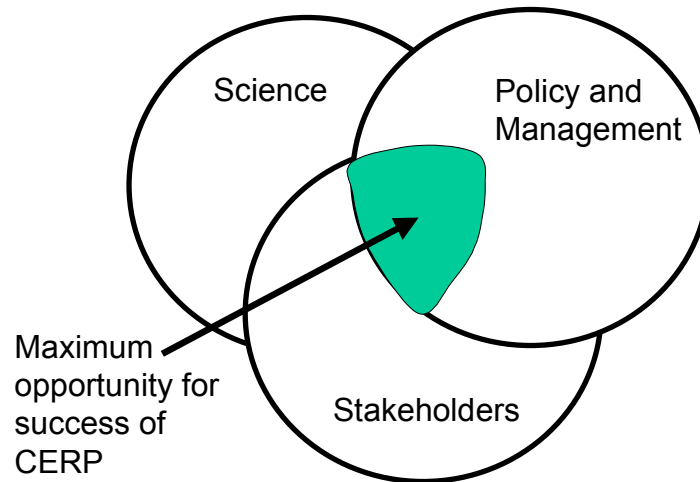
**Figure 7b-3-4.** Integrating the Inputs of Science, Policy/Management and Stakeholders is the Only Way to Successfully Meet the Goals and Objectives of the Comprehensive Everglades Restoration Plan

As summarized above, the formal performance assessment reports issued at 2- to 5-year intervals by RECOVER will 1) report responses in the natural and human systems to the implementation of CERP, 2) identify any performance problems attributable to CERP, and 3) identify potential options for resolving undesirable performance or for improving the performance of the plan based on new information from monitoring and research. When there is agreement between the USACE and the SFWMD (or other local sponsor) that performance problems or other opportunities for improved performance should be addressed, RECOVER will assist in the development of a Comprehensive Plan Modification Report or other appropriate decision document. This report/document will describe either the reformulation of the plan or the changes in operations that will be required to resolve performance problems or to make improvements based on new information obtained from monitoring and research.

The suggested steps in this process are as follows:

1. The RECOVER Adaptive Assessment Team identifies any system-level performance problem or new information that can lead to an improvement in the performance of the plan.

2. RECOVER Program Managers (USACE and SFWMD) informally consult with senior management in their agencies, respectively, regarding any performance problems or new opportunities to improve the performance of the plan. These consultations produce agreement on an initial set of alternative solutions for addressing the problems and opportunities.

3. The RECOVER Comprehensive Plan Refinement and Model Refinement Teams coordinate modeling to better define the range of alternative solutions for improving plan performance.

4. The Adaptive Assessment and Comprehensive Plan Refinement Teams prepare a formal performance assessment report that fully defines the performance issues and

opportunities, and documents the alternative solutions that were modeled. This assessment report is much like a mini-reconnaissance study, in that it describes the problem(s) and opportunities, and identifies a range of potential actions.

5. The RECOVER performance assessment report goes through agency and public review, and may be reviewed by the South Florida Ecosystem Restoration Task Force.

6. In response to agency and public review and comment, the Comprehensive Plan Refinement Team assists in the drafting of a Comprehensive Plan Modification Report or other appropriate decision document. The Modification Report (or other decision document) can be likened to a mini-feasibility study, in that it includes a full analysis of costs, benefits and improvements in plan performance, and identifies a preferred plan.

7. The Comprehensive Plan Modification Report (or other appropriate decision document) goes through agency and public review.

Any RECOVER assessment that shows that the responses of CERP performance measures is sufficiently undesirable, based on assessment criteria developed by the Adaptive Assessment Team (section II), should initiate the review of alternative solutions described above. A proposed framework for organizing the review of potential alternatives for resolving performance problems or improving performance of the plan, and for selecting a preferred alternative, is shown in **Figure 7b-3-5**. This "decision tree" suggests an organized pathway that can lead to a decision regarding the most effective and efficient action for dealing with any performance problem or performance opportunities. The decision tree leads to the following potential actions:

1. Modify current operations of the plan

2. Modify the design or operational plan for a project of the plan not yet implemented

3. Modify the sequence or schedule for implementation of the plan

4. Modify current operations of the plan

5. Add new components to the plan or delete components not yet implemented

6. Remove or modify a component of the plan already in place

7. Apply more than one of the above options

The preferred alternative plan identified in the Comprehensive Plan Modification Report or other decision document will go through public and agency review, and comply with the conditions of the Programmatic Regulations, prior to action.
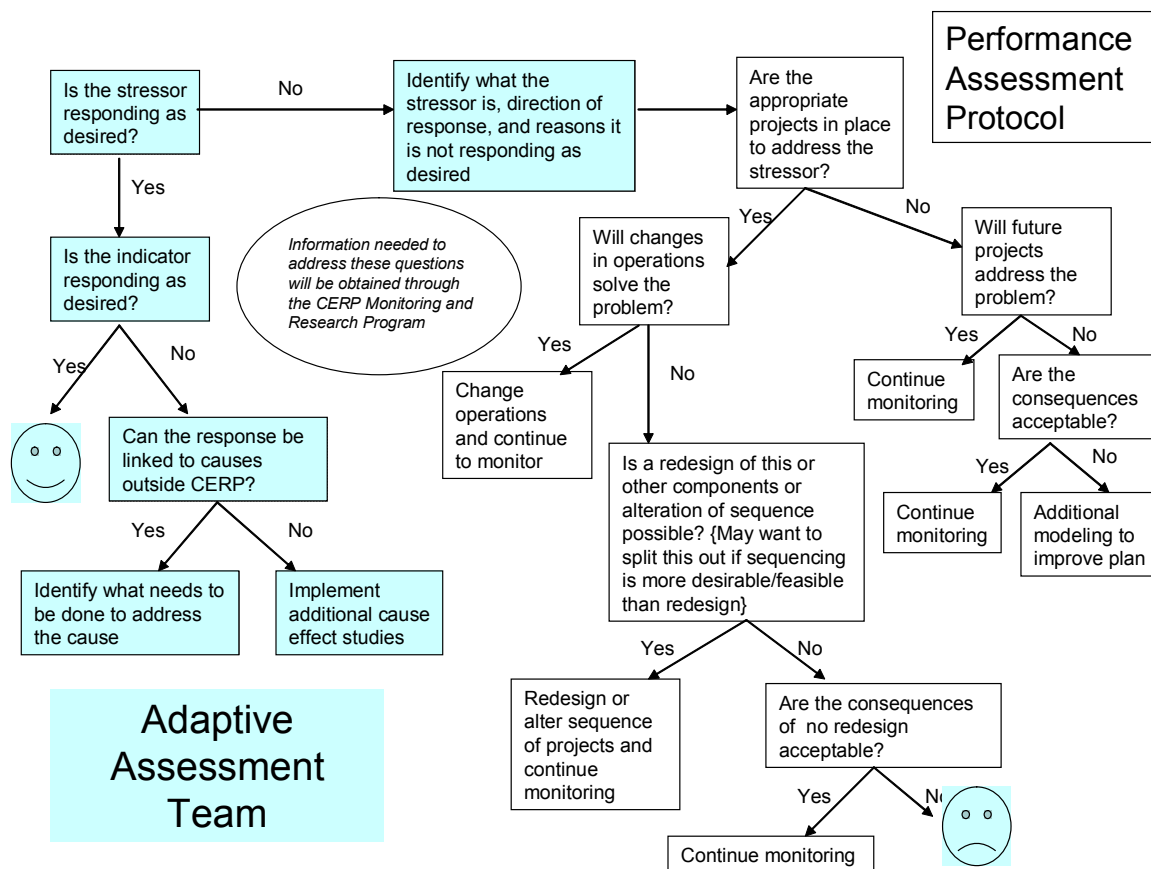
Figure 7b-3-5. Decision Tree for Determining Changes to the Comprehensive Everglades Restoration Plan.

# LITERATURE CITED

RECOVER Adaptive Assessment Team. 2000. *An Adaptive Assessment Strategy for the Comprehensive Everglades Restoration Plan*. West Palm Beach, FL.

RECOVER. 2001. *First Draft CERP Systemwide Monitoring and Assessment Plan*. West Palm Beach, FL.